Implications of the Uncertainties in the *n* + *Li* Cross Sections

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The most important reaction for breeding tritium is the ^{6}Li(n,t)α reaction. This together with the neutron inelastic three-body breakup of Li, ^{6}Li(n,n')dα, are the most important neutron reactions on ^{6}Li at neutron energies up to about 20 MeV. However, the tritium breeding reaction is uncertain by about 25% for all neutron energies above 0.5 MeV. Similarly, the three-body reaction is uncertain for neutron energies above 3 MeV. Indeed, the Los Alamos and Lawrence Livermore National Laboratories' cross-section libraries for these two reactions are quite different at these neutron energy regions. In this project, we have been examining the implications of these uncertainties in weapons simulations for systems currently in the nation's nuclear stockpile.

The uncertainty in the ENDF/B-VI ^{6}Li(n,t) cross section at energies below 1 MeV (the "standards" region) was based on scaling up the uncertainty given by propagating the covariances of the R-matrix parameters to account for the fact that chi-square per degree of freedom for the fit exceeded unity. At higher energies for the ^{6}Li(n,t) cross section, and also for the ^{6}Li(n,n') cross section, the uncertainties were estimated from the scatter in the experimental data and from the deviation from other evaluations. It is interesting to note that a new R-matrix analysis of the ^{7}Li system is giving ^{6}Li(n,t) cross sections very similar to those of ENDF/B-VI at energies below 4 MeV.

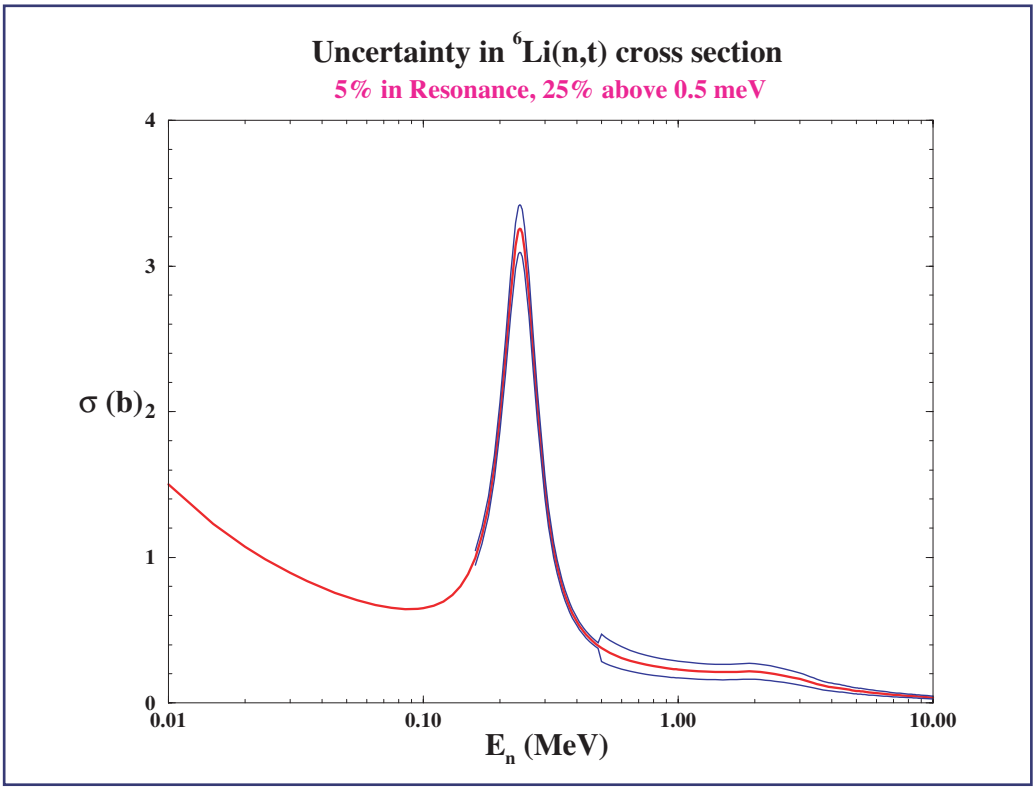

***Figure 1—** Uncertainty in ^{6}Li(n,t) cross section.*

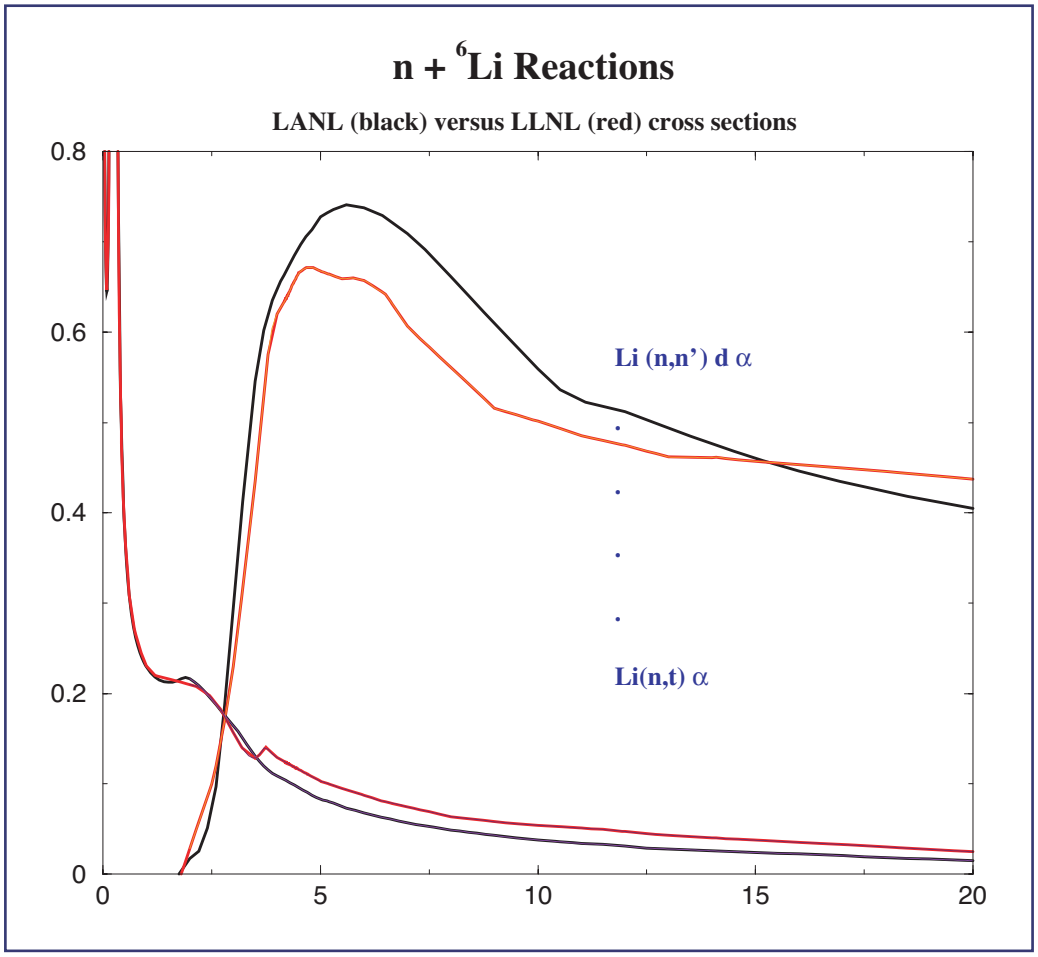

Figure 2—
n + ^{6}Li reactions.

The Nuclear Data Interface (NDI) allows straightforward manipulation of the nuclear cross section and neutron transport scattering matrices for the present sensitivity studies. We carried out a series of simulations testing the sensitivity to the Los Alamos and Lawrence Livermore National Laboratories' Li cross-section libraries and the sensitivity to the total uncertainty in the cross sections. We also examined the tritium production as a function of neutron energy. These calculations show some unexpected but important results.

From these studies we concluded that there is a need for a high-accuracy measurement of the tritium breed cross section at neutron energies above 0.5 MeV. Experimental feasibility studies suggest that a 5% measurement is possible at the Los Alamos Neutron Science Center.

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